PERFORMANCE OF HOT MIX ASPHALT USING PEAT MODIFIED ASPHALT BINDER

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DEDICATION

I would like to announce my appreciation to Allah Almighty for his grace, guidance and protection of me during my Ph.D. study.

Specially Dedicated to

My Parents

My Lovely Brothers and Sisters

My love to you will always remain and thank you for your Support, Guidance, Patience, Joyfulness to make this experience complete.

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"May ALLAH Bless Us All To Achieve Excellence in Life"

ABSTRACT

In recent years, the road distresses have caused millions of ringgit to maintenance cost. Hence, allowed paving technologists to examine the benefits of introducing additives and modifiers. As a result modifiers such as fillers, extenders polymers (natural and synthetic), fibers among others, are introduced to be mixed with asphalt. This study was conducted to investigate the use of parit Nipah peat (PNpt) to be mixed with asphalt, both of unaged and aged conditions to improve the performance of asphalt mix. The physical properties, storage stability and rheological properties of base asphalt and PNpt modified asphalt (PNpt.M.A.) were measured. It was observed that the rheological properties differ considerably between the base asphalt and PNpt. The rheological changes associated with the ageing of PNpt.M.A are linked to a breakdown of the molecular structure of the binders to form a lower molecular weight peat substructure. Based on the SHRP rutting parameters, adding PNpt decreases rutting for the binder at high temperature rheological properties indicated that 5% PNpt or PNpt.M.A. 5 is the optimum content as a modifier with asphalt. After the optimum content of PNpt, tests were conducted to investigate the performance characteristics, where the mixes were prepared according to the wet process. Mechanical testing on the PNpt asphalt mixes have demonstrated that the asphalt mix stiffness, rutting performance at high temperature were found to be improved. Modification indices with the PNpt 5% showing a peak modification with 45.6% percentages increasing to enhancement towards against rutting deformations with consideration the effect of aging as an average of the mixture work interim of rutting resistance. However, the durability studies have indicated that PNpt are slightly susceptible with the presence of rutting. The stiffness modules of mixes were found to be affected by the testing temperatures and frequencies. As conclusion, asphalt pavement performance can be enhanced by using PNpt as modifier is major road distresses. In addition, it has the excellent potential for great modification of the asphalt binder and mixture.

ABSTRAK

Sejak kebelakangan ini, peningkatan trafik serta tekanan tayar, trak yang besar dan berat dan rekabentuk gandar baru menyebabkan menyebabkan kos jutaan ringgit untuk penyelenggaraan. Oleh itu, pemahaman yang lebih baik tentang tingkah laku dan sifat asfalt, juga dengan perkembangan teknologi, membolehkan teknologis mengkaji manfaat dalam memperkenalkan bahan tambah dan bahan pengubahsuai. Bahan pengubahsuai seperti bahan pengisi, polimer (semulajadi dan sintetik) dan fiber diperkenalkan untuk dicampurkan dengan asphalt agar dapat meningkatkan ciri-ciri asphalt sebagai bahan pengikat. Kajian ini dijalankan bagi mengkaji penggunaan partikel tanah gambut Parit Nipah (PNpt) untuk dicampur dengan asphalt bagi kedua-dua keadaan iaitu tanpa rawatan dan kajian jangka pendek bertujuan untuk meningkatkan prestasi campuran asfalt. Ciri-ciri fizikal, kestabilan penyimpanan dan rheologi bagi asfalt asas dan asfalt PNpt yang diubahsuai (PNpt.M.A.) juga diukur. Parameter asas digunakan untuk menggambarkan kepentingan PNpt sebagai bahan pengubah. Didapati bahawa kestabilan penyimpanan bergantung kepada kandungan bahan yang terdapat dalam asphalt tersebut. Bagaimanapun, pemerhatian mendapati bahawa sifat rheologi jauh berbeza antara asfalt asas dan PNpt. Perubahan rheologi berkait dengan penuaan PNpt.M.A. dikaitkan dengan pecahan struktur molekul pengikat untuk membentuk substruktur molekul gambut yang lebih rendah. Ini mengakibatkan peningkatan tingkah laku selepas penuaan berbanding peningkatan tingkah laku keanjalan di dalam asfalt asas. Berdasarkan parameter kegagalan permukaan jalan disebabkan oleh kesan roda SHRP, penambahan PNpt mengurangkan kegagalan permukaan jalan disebabkan oleh kesan roda pada suhu tinggi sifat rheologi menunjukkan bahawa 5% PNpt atau PNpt.M.A. 5 ialah kandungan optimum sebagai bahan pengubah suai asfalt. Selepas mendapatkan kandungan PNpt yang optimum, ujian telah dijalankan untuk mengkaji ciri-ciri prestasi campuran asfalt PNpt, di mana campuran telah disediakan mengikut

proses basah. Ujian mekanikal terhadap campuran asfalt PNpt telah menunjukkan bahawa ciri kekerasan campuran asfalt, prestasi bagi kegagalan permukaan jalan disebabkan oleh kesan roda pada suhu tinggi didapati bertambah baik berbanding dengan asfalt asas PNpt.MA 0. Bagaimanapun, kajian ketahanan telah menunjukkan bahawa PNpt mudah terdedah dengan kehadiran kegagalan permukaan jalan disebabkan oleh kesan roda. Kajian ketahanan juga dilakukan untuk mengkaji sifat penuaan jangka masa pendek bagi PNpt. Didapati bahawa ciri kekerasan bagi campuran asfalt meningkat disebabkan kesan gabungan di antara penuaan jangka masa pendek bagi campuran asfalt. Modulus ciri kekerasan campuran didapati terjejas oleh ujian suhu dan frekuensi. Kesimpulannya, prestasi turapan asfalt boleh ditingkatkan dengan menggunakan PNpt sebagai bahan pengubah suai bagi masalah jalan utama. Di samping itu, terdapat potensi yang sangat baik untuk pengubahsuaian bahan pengikat dan campuran asfalt.

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A	-	Aging
AI	-	Aging Index
AI	-	Asphalt Institute
AASHTO	-	American association of state highway and transportation officials
ASTM	-	American society for testing and materials
ANOVA	-	Analysis of Variance
AC	-	Aging Condition
BT	-	Asphalt Binder Type
CGN	-	Compaction Gyration Number
DSR	-	Dynamic Shear Rheometer
DG	-	Dense-Grade
ESALs	-	Equivalent Single Axle Loads
G_{sb}	-	Bulk Specific Gravity of Aggregate
G_b	-	Specific Gravity of Asphalt
G_{se}	-	Effective Specific Gravity of Aggregate
G_{mb}	-	Specific Gravity of Aggregate
G_{mm}	-	Maximum Specific Gravity of Paving Mixture
HMA	-	Hot Mixture Asphalt
ITS	-	Indirect Tensile Strength
MSCR	-	Multiple Stress Creep Recovery
MT	-	Mixing Temperature

$N_{initial}$	-	Compaction Parameter
N_{design}	-	Compaction Parameter
$N_{maximum}$	-	Compaction Parameter
NAPA	-	National Asphalt Pavement Association
SHRP	-	Strategy Highway Research Program
OAC	-	Optimum Asphalt Content
P_{be}	-	Effective Asphalt Content, percent by total weight of Mixture
PAV	-	Pressure Aging Vessel
P_b	-	Asphalt. Percent by total weight of mixture
PNpt	-	Parit Nipah Peat
PNpt.M.A	-	Parit Nipah Peat Modified Asphalt
PG	-	Performance Grade
RTFO	-	Rolling Thin Film Oven
RV	-	Rotational Viscometer
SMA	-	Stone Matrix Asphalt
SFE	-	Surface Free Energy
STA	-	Short-Term-Aging
SGC	-	Superpave Gyratory Compactor
TSR	-	Tensile Strength Ratio
UTM	-	Universal Testing Machine
VFA	-	Voids Filled Asphalt
VMA	-	Voids Mineral Aggregate
VTM	-	Voids in Total Mixture

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